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Author(s)	Ho, Ju-shey; Do, Tran-the
Citation	PUBLICATIONS OF THE SETO MARINE BIOLOGICAL LABORATORY (1984), 29(4-6): 333-358
Issue Date	1984-10-31
URL	http://hdl.handle.net/2433/176090
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Type	Departmental Bulletin Paper
Textversion	publisher

THREE SPECIES OF LERNAEOPODIDAE (COPEPODA) PARASITIC ON FISHES OF JAPAN, WITH PROPOSITION OF A NEW GENUS AND DISCUSSION OF *CHAROPINOPSIS* YAMAGUTI, 1963

JU-SHEY HO

Department of Biology, California State University,
Long Beach, California, 90840, U.S.A.

and

TRAN THE DO

Ocean Research Institute, University of Tokyo,
Nakano-ku, Tokyo, 164, Japan

With Text-figures 1–16

In 1980 and 1981, one of us (TTD) conducted a survey of copepod parasites of the fishes of Kojima Bay in Okayama Prefecture. He examined 770 fishes (in 54 species) and recovered from them 42 species of copepod parasites. Twelve of these Kojima Bay parasites have already been treated elsewhere (Tran The Do, 1981; Tran The Do and Kasahara, 1982; Ho and Tran The Do, 1982; Tran The Do and Ho, in press; Ho, Tran The Do and Kasahara, in press). In this report, we shall deal with three species of the collected parasites that belong to the Family Lernaeopodidae.

In the course of our study of these newly collected Japanese lernaeopodids, we felt the necessity of reexamining the specimens of *Brachiella elegans* Richiardi that were reported by Wilson (1915) from Woods Hole, Massachusetts. Unexpectedly, this reexamination of Wilson's material led us to establish a new genus, *Eobrachiella*, for accommodation of one of the three lernaeopodids from Kojima Bay. We have also discovered that the character states of *Charopinopsis*, which was erected by Yamaguti (1963) for accommodation of a spurious *Charopinus* species (*C. quaterina* Wilson, 1935), needed to be reconsidered. A discussion on this matter was made possible through a study of the collection of *Charopinopsis quaterina* (Wilson) that was made by one of us (JSH), off Key West, Florida.

We adopt Kabata's (1979) terminology in the present treatment of the Japanese lernaeopodids, except for the posteriormost paired structures called "uropods." We disagree with Kabata in calling them "uropods", because we consider them not to be homologous to the malacostracan uropods, which are the last pair of the abdominal appendages located at the posteriormost part of the growth zone. Since the posteriormost paired structures in all modern copepods are carried by the anal somite, which is located posterior to the growth zone, they can not be treated as homologous to the uropods. Thus, we shall follow the traditional terminology and call this paired structures the caudal rami.

The type specimen has been deposited in the United States National Museum of Natural History,

Publ. Seto Mar. Biol. Lab., XXIX (4/6), 333–358, 1984. (Article 9)

Smithsonian Institution, Washington, D. C. We would like to thank Dr. Shin-ichi Uye of the Faculty of Applied Biological Science, Hiroshima University for supplying us fishes for parasite examination and Dr. Shogoro Kasahara of the same institution for the use of facilities in his laboratory for carrying out the preliminary work of this report. We are indebted to Dr. Roger F. Cressey of the United States National Museum of Natural History for arranging the loan of the specimens of "*Brachiella elegans* Richiardi."

Neobrachiella trichiuri (Yamaguti, 1939)

(Figs. 1–3)

Material examined: Two ovigerous females, each carrying a dwarf male, found in oral cavity of 2 *Trichiurus lepturus* L. caught on 22 July, 1980.

Female: Body (Fig. 1A) consisting of a long, cylindrical cephalothorax, a subcylindrical trunk, and two pairs of posterior processes. Head covered with a dorsal shield (Fig. 1D). Cephalothorax bearing a pair of prominent lateral spherical swellings at the base where the second maxillae arise (Figs. 1B, 2G). Trunk longer than wide and connected to cephalothorax by a short neck that bears two pairs of small nodules (see Fig. 1B). Posterior end of trunk truncate (Fig. 1C), bearing a short genital process between ventral pair of posterior processes, which are about 2/3 the length of the dorsal pair. Caudal ramus absent. Measurements of two specimens (in mm): cephalothorax length 2.20; width 0.56, 0.70; second maxilla 0.58, 0.68; trunk length 1.75, 1.95; width 1.24, 1.78; genital process 0.34, 0.35; dorsal posterior process length 2.40, 2.62; ventral posterior process length 1.45, 1.90; egg sac length 1.35, 3.40; width 0.48, 0.70.

First antenna (Fig. 1E) 4-segmented, with robust, unarmed basal segment; second and third segments each armed with 1 seta; and terminal segment (Fig. 1F) with 3 tubercles, 1 digitiform seta and 4 flagelliform setae. Second antenna (Fig. 2A) consisting of a large protopod and two extremely unequally developed rami; exopod (Fig. 2B) large, fleshy, covered with spinules and bearing 2 small subterminal papillae; and endopod (Fig. 2C) small, bearing distally a patch of spinules and 2 spines. Tip of labrum (Fig. 2D) with a tuft of setules surrounding the spinous, central rostrum. Mandible (Fig. 2E) with 3 primary, 2 secondary, and 5 basal teeth. First maxilla (Fig. 2F) with small exopod tipped with 2 setae and a large endopod bearing terminally 2 large papillae and 1 small seta; dorsal surface of endopod expanded and spinulose. Second maxillae (Figs. 1B, 2G) short and fused, with prominent excretory duct. Maxilliped (Fig. 2H) 2-segmented; corpus (basal segment) bearing a spiniform seta and a patch of spinules on its medial surface; subchela (terminal segment) bearing a prominent basal seta and a slender barb accompanied by a patch of spinules at its base (Fig. 2I); terminal claw slender, without secondary teeth.

Male: Body (Fig. 3A) measuring 670×335 μm, with a distinct constriction between cephalothorax and trunk. Caudal ramus lacking. First antenna (Fig. 3B) without inflated basal segment, armature generally as in female, only different

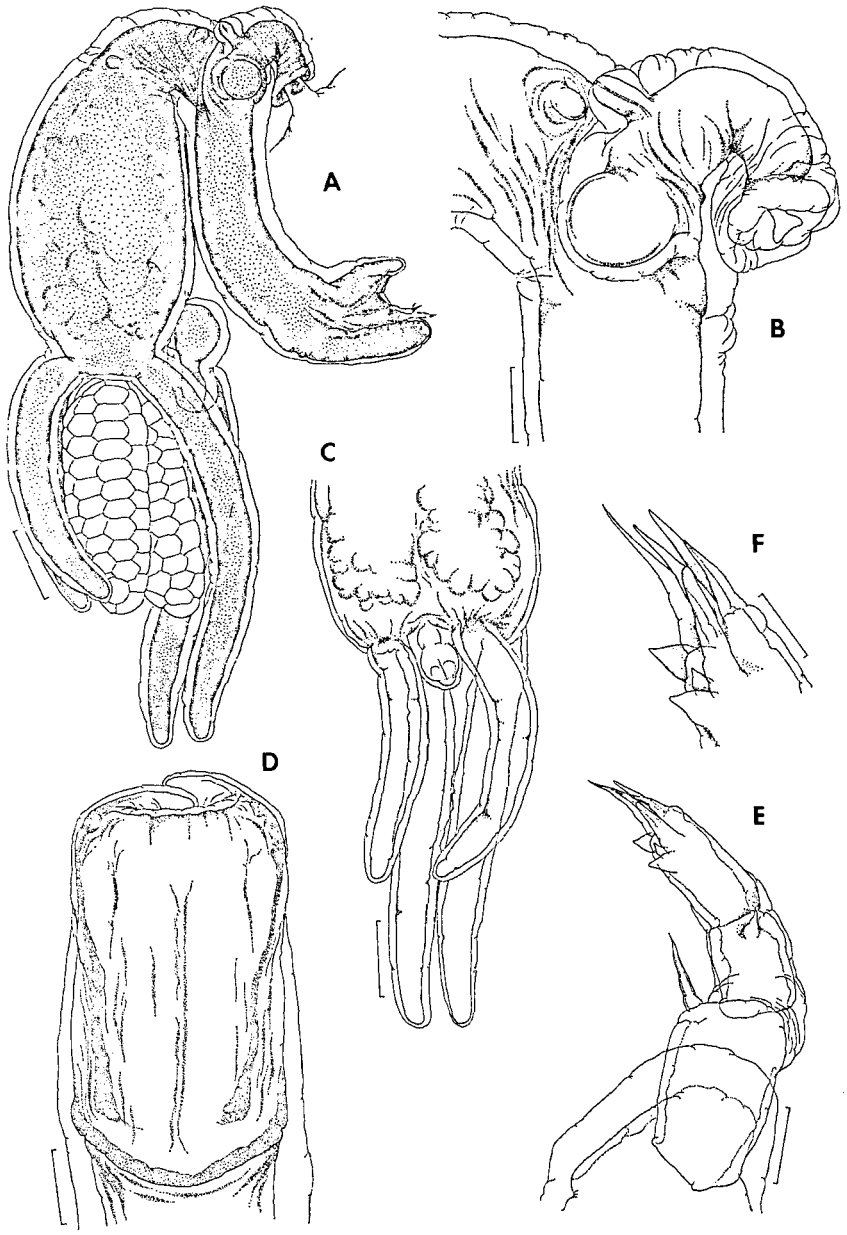

Fig. 1. *Neobrachiella trichiuri* (Yamaguti, 1939), female. A, habitus, lateral; B, base of cephalothorax, lateral; C, posterior part of body, ventral; D, anterior part of cephalothorax, dorsal; E, first antenna; F, tip of first antenna. Scale: 0.5 mm in A, C; 0.2 mm in B, D; 20 μm in E; 10 μm in F.

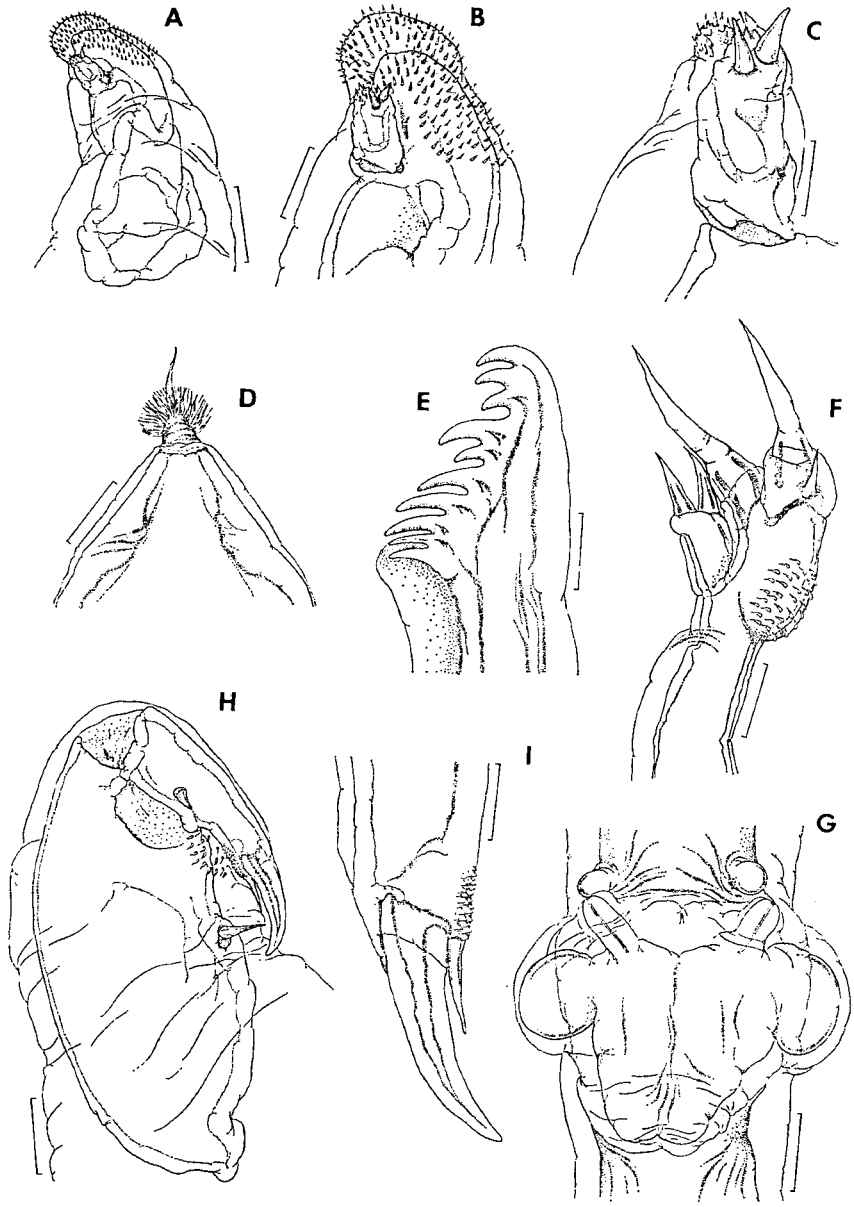

Fig. 2. *Neobrachiella trichiuri* (Yamaguti, 1939), female. A, second antenna; B, tip of second antenna; C, tip of second antenna endopod; D, tip of labrum; E, tip of mandible; F, first maxilla; G, second maxillae, ventral; H, maxilliped; I, tip of maxilliped. Scale: 0.1 mm in A; 50 μm in B; 20 μm in C, D, F, I; 7 μm in E; 0.2 mm in G; 50 μm in H.

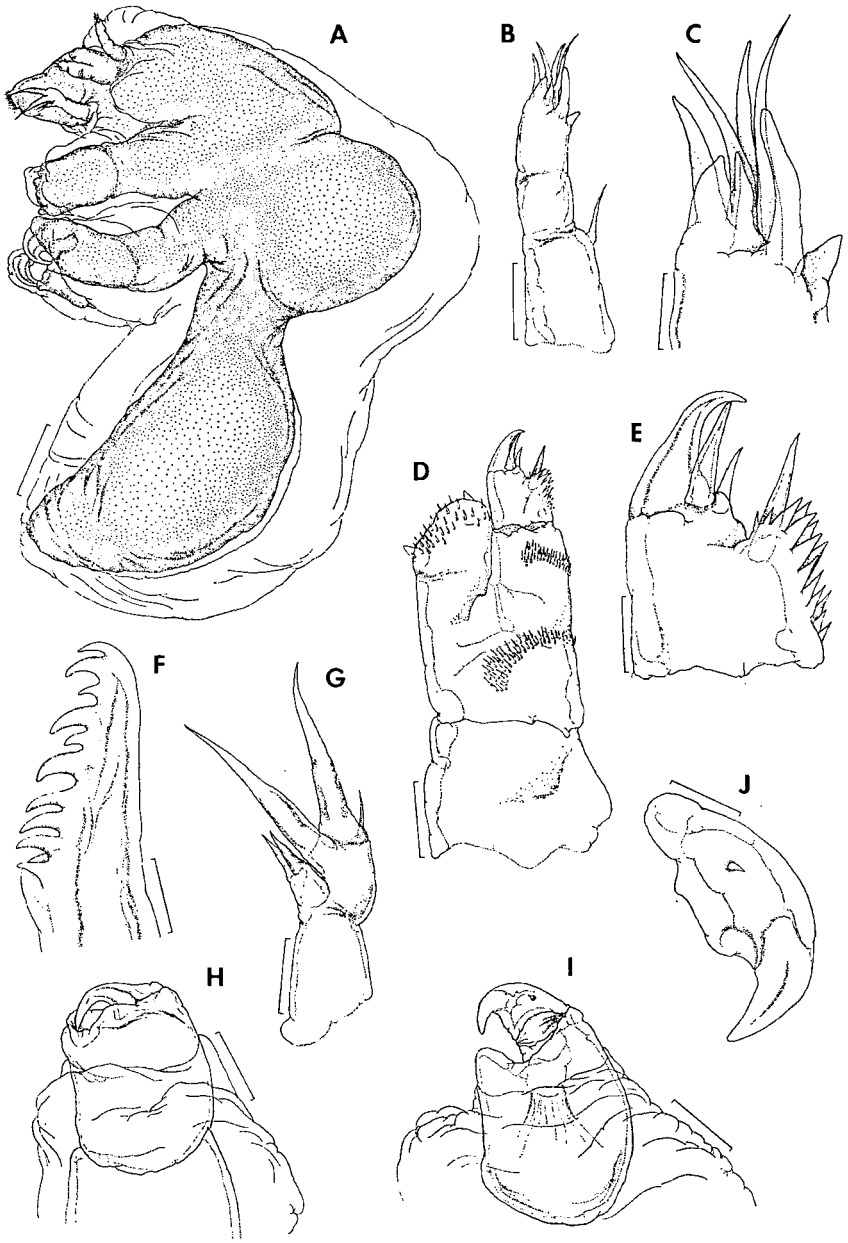

Fig. 3. *Neobrachiella trichiuri* (Yamaguti, 1939), male. A, habitus, lateral; B, first antenna; C, tip of first antenna; D, second antenna; E, tip of second antenna endopod; F, tip of mandible; G, first maxilla; H, second maxilla; I, maxilliped; J, tip of maxilliped. Scale: 0.1 mm in A; 20 μm in B, D, G, J; 7 μm in C; 8 μm in E; 5 μm in F; 50 μm in H, I.

in having relatively larger tubercles at distal end (Fig. 3C). Second antenna (Fig. 3D) bearing two bands of spinules on posteroinner surface, one on protopod and another one on endopod; exopod bearing 2 subterminal papillae on its outer surface and a patch of spinules on inner surface; endopod apparently 2-segmented, distal segment (Fig. 3E) armed with a recurved hook, 2 spines, 1 seta, and a patch of denticles. Mandible (Fig. 3F) generally as in female. First maxilla (Fig. 3G) different from female in having unornamented dorsal surface in endopod. Second maxilla (Fig. 3H) 2-segmented; corpus quadrangular, with concave distomedial corner accommodating tip of subchela, which is unarmed. Maxilliped (Fig. 3I) also 2-segmented; massive corpus with prominent subtriangular outgrowth in distomedial corner; subchela short, sturdy and bearing 2 small setae as shown in Fig. 3J.

Remarks. Until 1963, this species was known as "*Clavellopsis trichiuri* Yamaguti, 1939," a lernaeopodid found attached to the palate of *Trichiurus lepturus* L. (=*Trichiurus japonicus*) from Toyama Bay in the Sea of Japan. Although it was later transferred by Yamaguti (1963) to *Isobranchia* Heegaard, 1947, the validity of Heegaard's genus was questioned by Pillai (1968: 133) and Kabata (1979: 386). Pillai (1968: 123) stated that the Japanese *C. trichiuri* "undoubtedly belongs to *Brachiella*," but based on Kabata's (1979) recent work, it should be placed in the newly erected genus, *Neobrachiella*.

There is a species of "*Brachiella*" living in the oral cavity of the Indian ribbonfish that has caused some confusion in the literature. The species in question was first reported by Gnanamuthu (1951) from *T. lepturus* (=*T. haumela*) at Madras and called "*Brachiella trichiuri*." This name was used by Pillai (1962, 1968) in reporting the same species of lernaeopodid from a different host, *Lepturacanthus savala* (Cuvier) (=*Trichiurus savala*), at Trivandrum. However, Kirtisinghe (1964) and Rangnekar (1967) held different view, they called their ribbonfish parasite "*Clavellopsis trichiuri* Yamaguti" and treated "*Brachiella trichiuri* Gnanamuthu" as a junior synonym. Pillai (1968: 123) was skeptical about this synonymy because "*Clavellopsis trichiuri* Yamaguti" had never been adequately characterized. With the rediscovery of Yamaguti's "*Clavellopsis trichiuri*," we can now proceed to untangle this confusion. Since Pillai's (1968) work has the most adequate treatment of the Indian form—"*Brachiella trichiuri* Gnanamuthu"—we shall compare it closely with our newly collected Japanese form—"*Clavellopsis trichiuri* Yamaguti."

There is not a slightest doubt that the Indian "*Brachiella trichiuri*" is a species of *Neobrachiella* and extremely close to the Japanese *Neobrachiella trichiuri* redescribed above. Our close comparison between them has yielded only two minor differences in the fine structure of the oral appendages. The mandible of the Japanese form (Fig. 2E) has only 2 secondary teeth and they are relatively large; however, in the Indian form there are either two or three (illustrated with two but stated with three in the text by Pillai) relatively small secondary teeth. The first maxilla of the Indian form does not have a patch of spinules as illustrated here in Fig. 2F for the Japanese form. Another slight difference was detected in the relative length of the

two pairs of posterior processes: while they are subequal in the Indian form, the ventral pair in the Japanese form is only about two-thirds of the dorsal pair (see Figs. 1A, 1C). Since these differences are still minute between these two forms of allopatrically occurring lernaeopodids, we suggest to treat them as two geographic forms, i.e. a Japanese *Neobrachiella trichiuri trichiuri* and an Indian *Neobrachiella trichiuri indica*.

Song and Chen (1976) and Song and Kuang (1980) reported "*Brachiella trichiuri* Gnanamuthu" from *T. lepturus* at Hainan Dao in the South China Sea. Based on the latter report, the Chinese *N. trichiuri* belongs to the *indica* form.

Trichiurus lepturus is the most widely distributed species of ribbonfish (Trichiuridae) that lives in the tropical and subtropical seas. However, its lernaeopodid parasite, *Neobrachiella trichiuri*, is so far known only from those populations occurring in the Indo-west Pacific region. Ho and Bashirullah (1977) could find only a caligid copepod, *Metacaligus uruguayensis* Thomsen, from the Caribbean population of *T. leptulus*. Nevertheless, it is interesting to point out that the same caligid copepod is also known from India but on another ribbonfish, *Lepturacanthus asvala*, which also harbors *N. trichiuri indica* (Pillai, 1962, 1968).

Neobrachiella brevicapita sp. nov.

(Figs. 4–5)

Material examined: Two ovigerous females found on gill filaments of 2 *Nibea albiflora* (Richardson) collected on 11 November, 1980.

Female: Body (Figs. 4A-C) with a rather short cephalothorax and a long trunk. A pair of prominent lateral swellings at base of cephalothorax (see Figs. 4C, D). Posterior end of trunk carrying two pairs of unequal processes, with longer pair located lateral to egg sacs and shorter pair (=caudal ramus) ventral to egg sacs. Genital process absent. Measurements of two specimens (in mm): cephalothorax length 1.05, 1.15; width 0.36, 0.49; trunk length 1.83, 1.98; width 0.72, 0.85; lateral posterior process length, 0.68, 0.81; ventral posterior process length 0.39, 0.65; egg sac length 2.03, 2.75; width 0.35, 0.4.

First antenna (Fig. 4E) 4-segmented, with inflated basal segment as in most *Neobrachiella*, terminal segment (Fig. 4F) armed with 4 tubercles, 1 digitiform seta and 2 flagelliform setae. Second antenna (Fig. 5A) with strongly deflected rami; sympod carrying 2 small inner setae; bulbous exopod bearing an apical papilla; and 2-segmented endopod tipped with a small hook and a slender seta (Fig. 5B). Tip of labrum (Fig. 5C) with a tuft of setules surrounding the spinous, central rostrum. Mandible (Fig. 5D) with 2 primary teeth, 2 unequal secondary teeth and 6 basal teeth. First maxilla (Fig. 5E) with 2 large terminal papillae on endopod and 2 small setae on exopod; dorsal surface of endopod bearing a patch of spinules. Second maxilla (Fig. 5F) separated, longer than cephalothorax, and tipped with a large bulla (Fig. 4G). Maxilliped (Fig. 5G) 2-segmented; corpus unarmed; subchela with

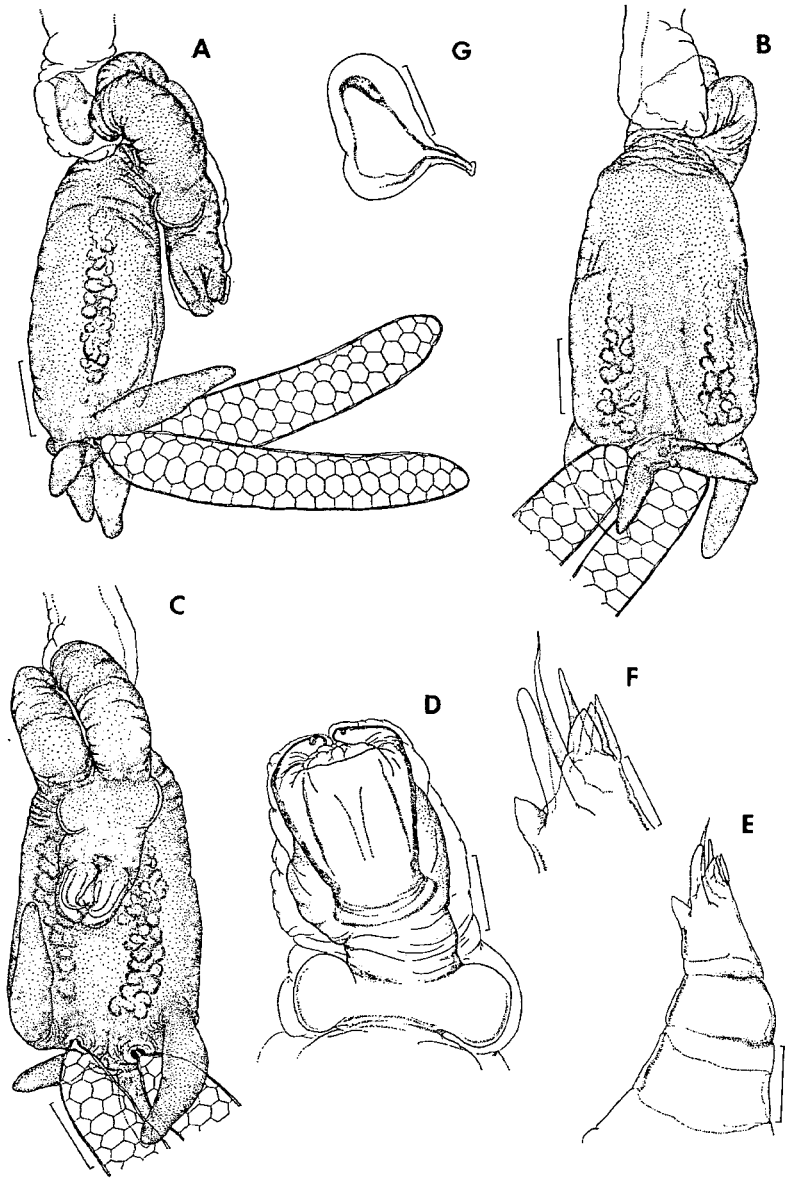

Fig. 4. *Neobrachiella brevicapita* sp. nov., female. A, habitus, lateral; B, same, ventral; C, same, dorsal; D, cephalothorax, dorsal; E, first antenna; F, tip of first antenna; G, bulla. Scale: 0.5 mm in A, B, C; 0.2 mm in D, G; 20 μm in E; 10 μm in F.

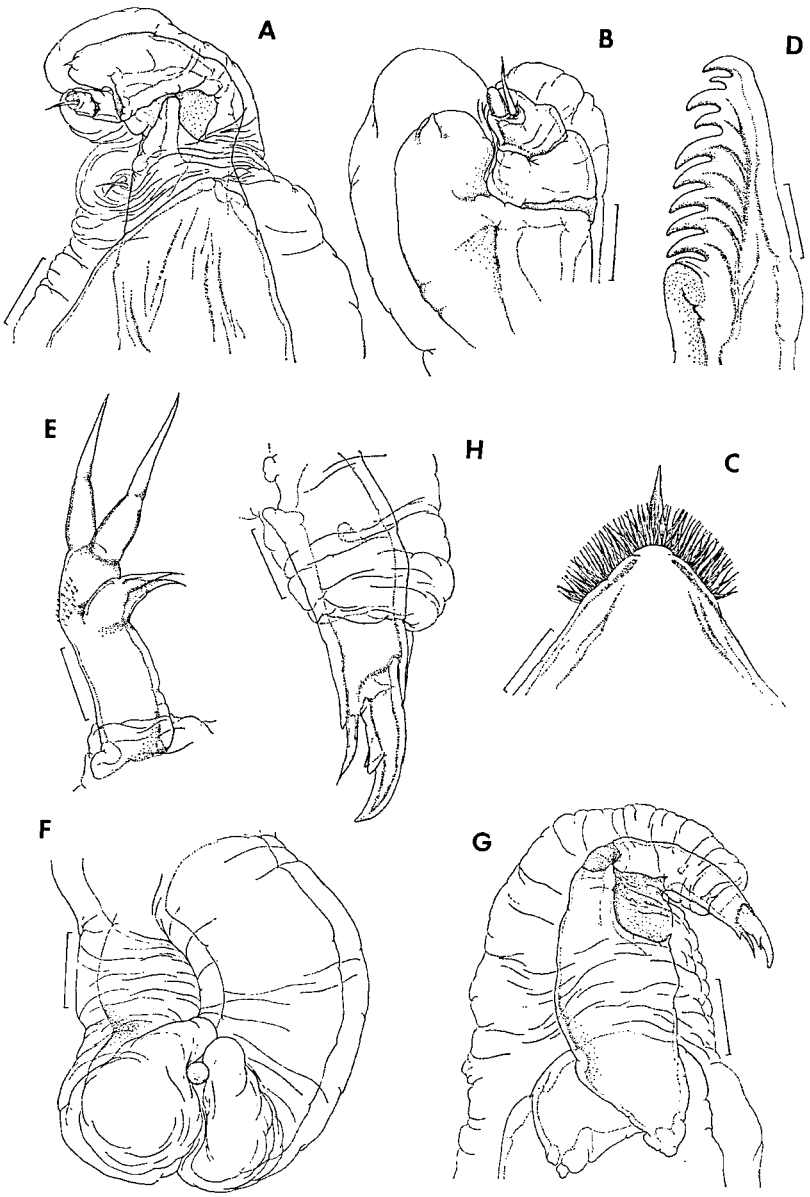

Fig. 5. *Neobrachiella brevicapita* sp. nov., female. A, second antenna; B, tip of second antenna; C, tip of labrum; D, tip of mandible; E, first maxilla; F, second maxillae; G, maxillipecd; H, tip of maxilliped. Scale: 50 μm in A; 20 μm in B, E, H; 10 μm in C; 7 μm in D, 0.2 mm in F; 0.1 mm in G.

distal half exposed outside of cuticular sheath and bearing a small basal seta and a stubby distal barb; terminal claw armed with two secondary teeth (see Fig. 5H).

Male: Unknown.

Remarks. The present species bears the closest resemblance to the Indian *Neobrachiella albida* (Rangnekar) (=*Charopinus albidus*), which is also parasitic on the scianid fishes (Rangnekar, 1956; Pillai, 1962). The similarity between these two scianid parasites are shown not only in the general appearance of the body but also in the fine structures of the mandible, first maxilla and maxilliped. However, in spite of their close resemblance the new species from Japan is distinguishable from the Indian *N. albida* in possessing a relatively short cephalothorax that bears a pair of lateral swellings at the base (see Fig. 4D).

Eobrachiella gen. nov.

Female: Body of *Brachiella* type, with cephalothorax shorter than trunk. Cephalothorax cylindrical with well developed dorsal shield. Trunk distinctly longer than wide and bearing a pair of long, modified caudal rami and another pair of posterolateral process. A prominent anal tubercle located between and dorsal to genital orifices. First antenna indistinctly 4-segmented, with well developed apical armature. Endopod of second antenna much smaller than exopod. Mandible with three secondary teeth. First maxilla with two large and one small terminal papillae and a small exopod tipped with two short setae. Second maxillae moderately long and separated. Maxilliped subchelate, bearing two secondary teeth on terminal claw.

Male: Body of *Neobrachiella* type, with cephalothorax separated from trunk by a waist-like constriction. Trunk fusiform and straight, ended in a pair of prominent caudal rami. First antenna as in female. Second maxilla with equally developed rami. Mandible with only one secondary tooth. First maxilla as in female, second maxilla subchelate as in *Neobrachiella* but maxilliped long and armed as in *Brachiella*. No thoracic legs.

Type-species: *Eobrachiella elegans* (Richiardi, 1880)

Etymology: The generic name is a combination of the Greek *eo* (early) and *brachiella* (arm, with diminutive ending; a generic name that is used as a suffix in two other genera of the Lernaeopodidae), alluding to its close affinity with *Brachiella*.

Remarks. The most outstanding feature of this new genus is to be found in the male. It has a *Neobrachiella*-form of body with *Brachiella*-type of maxilliped. The female is very much like a typical *Neobrachiella* except for the relatively short cephalothorax.

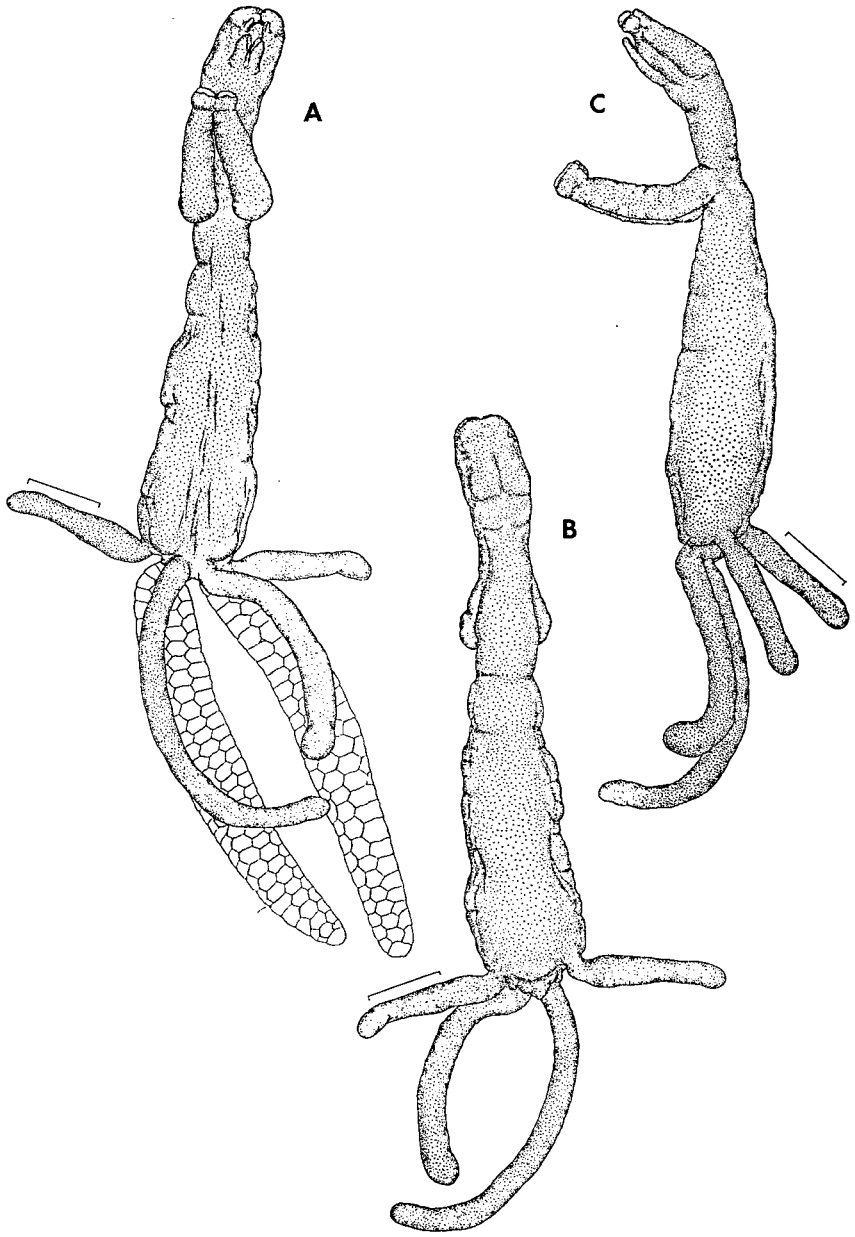

Fig. 6. *Eobrachiella elegans* (Richiardi, 1880) on *Seriola zonata* from Woods Hole, Massachusetts; female. A, habitus, ventral; B, same, dorsal; C, same, lateral. Scale: 1 mm in all drawings.

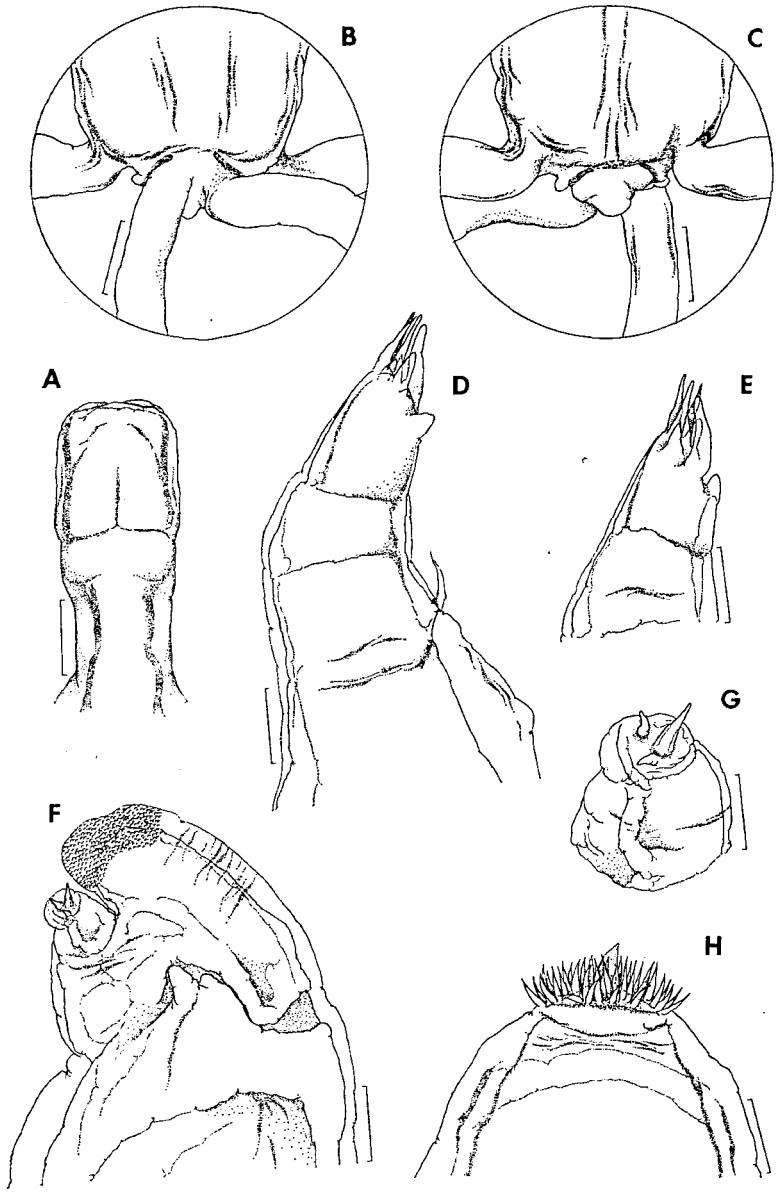

Fig. 7. *Eobrachiella elegans* (Richiardi, 1880) on *Seriola zonata* from Woods Hole, Massachusetts; female. A, cephalothorax, dorsal; B, posterior part of trunk, ventral; C, same, dorsal; D, first antenna; E, tip of first antenna; F, second antenna; G, second antenna endopod; H, tip of labrum. Scale: 0.5 mm in A, B, C; 20 μm in D, E, G, H; 50 μm in F.

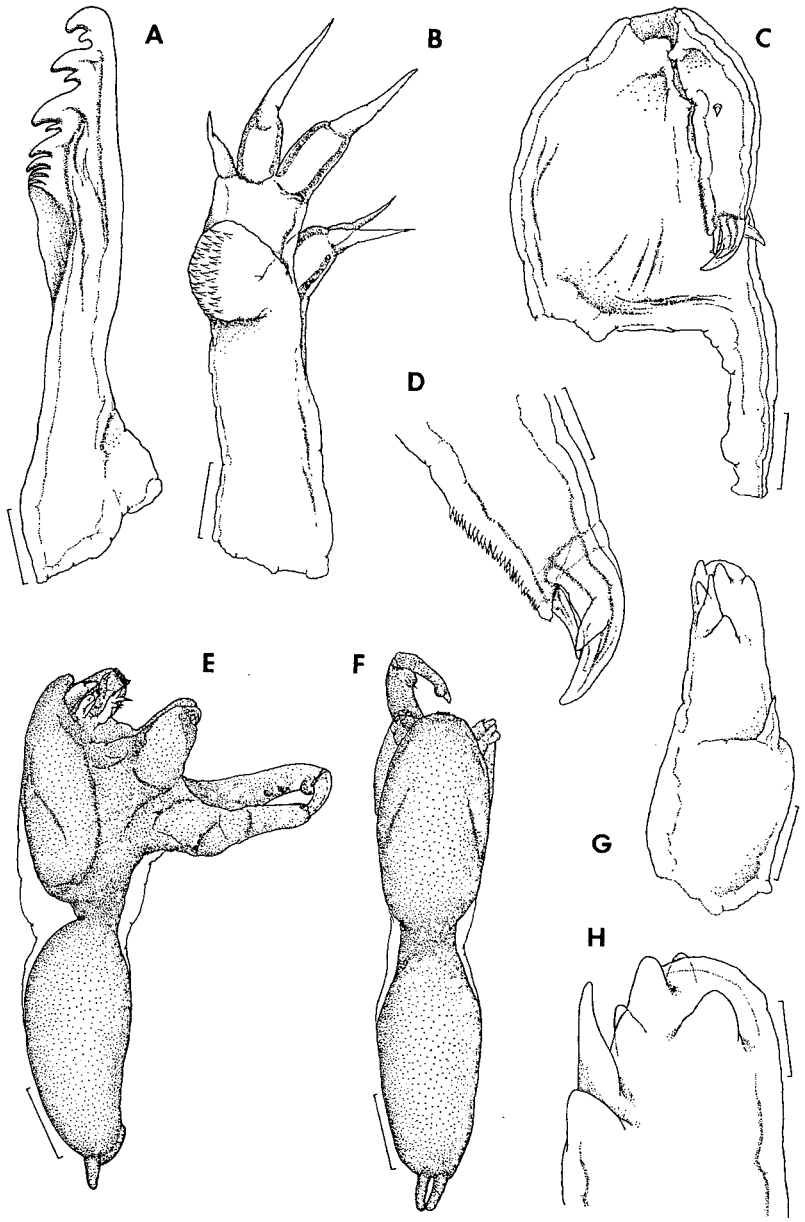

Fig. 8. *Eobrachiella elegans* (Richiardi, 1880) on *Seriola zonata* from Woods Hole, Massachusetts. Female: A, mandible; B, first maxilla; C, Maxilliped; D, tip of maxilliped. Male: E, habitus, lateral; F, same, dorsal; G, first antenna; H, tip of first antenna. Scale: 20 μm in A, B, D, G; 50 μm in C; 0.2 mm in E, F; 7 μm in H.

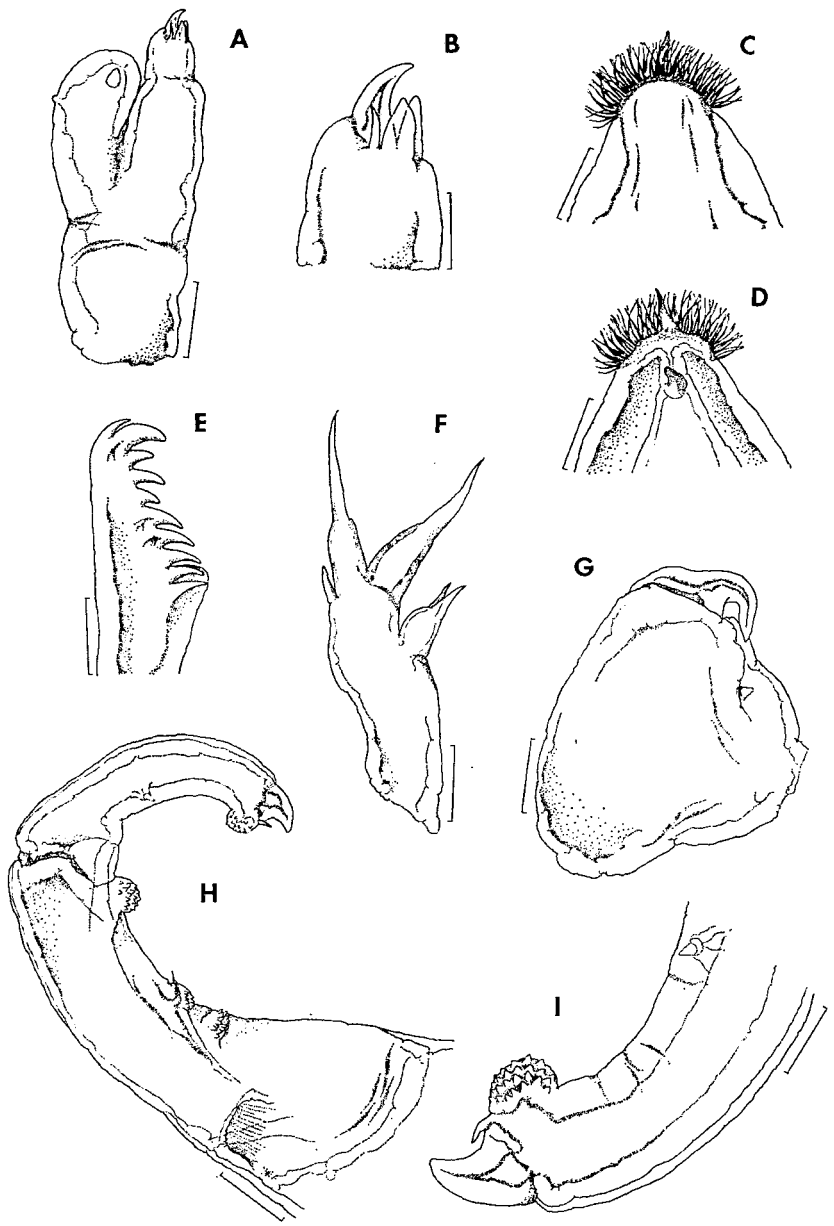

Fig. 9. *Eobrachiella elegans* (Richiardi, 1880) on *Seriola zonata* from Woods Hole, Massachusetts; male. A, second antenna; B, tip of second antenna endopod; C, tip of labrum, outer; D, tip of labrum, inner; E, tip of mandible; F, first maxilla; G, second maxilla; H, maxilliped; I, tip of maxilliped. Scale: 20 μm in A, C, D, F, I; 7 μm in B, E; 50 μm in G, H.

In the course of our study on the "*Brachiella seriolae* Yamaguti & Yamasu, 1960," which was taken from a yellow tail (*Seriola quinqueradiata* Temminck et Schlegel) in Kojima Bay, we discovered, to our surprise, the above mentioned unusual character

state in the male. This unexpected discovery led us to carry out an exhaustive search of literature for the male lernaeopodids that exhibit the similar state of peculiar character. We succeeded in finding two species, namely, "*Brachiella elegans* Richiardi" and "*Charopinus quaterinus* Wilson." We shall deal with *B. elegans* here and leave *C. quaterinus* to a later section, because the latter is not a member of this new genus.

The name "*Brachiella elegans*" was first proposed by Richiardi (1880) for an Italian lernaeopodid without giving any description or figures and, in 1899, Brian gave it a brief description and a drawing of female in ventral view. In spite of Brian's insufficient characterization of *B. elegans* under a temporary name: "*Brachiella* (*elegans* Rich. ?)," Wilson (1915: 708) went ahead and assumed that both Richiardi and Brian were dealing with the same species and proceeded further to conclude that his specimens (5 females and 1 male) recovered from *Seriola zonata* (Mitchill) at Woods Hold, Massachusetts was attributable "to the same species that Brian figured." Apparently, the only solution to this enigma is to restudy the lernaeopodids of *Lichia amia* (Linnaeus) from Italy and those of *Seriola zonata* from the northeastern United States. Since Italian specimens are at the present inaccessible to us, we decided to reexamine the American specimens of *B. elegans* that were deposited in the United States National Museum of Natural History in Washington, D. C. The circumstance is as such we can not but tentatively assume that Richiardi (1880), Brian (1899), and Wilson (1915) were all dealing with the same species of lernaeopodid.

As shown in Figs. 4–8, the female in Wilson's (1915) material from Woods Hole is clearly identifiable with *Neobrachiella*, it resembles particularly the hake parasite, *N. insidiosa* (Heller). The male (Figs. 8E–H, 9A–I) is also very much like a *Neobrachiella*, except for the maxilliped (see Figs. 9H, I), which is a typical *Brachiella*-form of appendage. Yet, it differs from the male of *Brachiella* in lacking the genital plates and genital processes. In short, the male of *Eobrachiella* exhibits a state of character intermediate between the *Brachiella* and *Neobrachiella* and can not be assigned to either genus.

The new genus is established with emphasis on the functional morphology of the male maxilliped. In almost all of the known lernaeopodids, the dwarf male attaches to its reproductive companion with both second maxillae and maxillipeds. It can be seen "pinching" on the female cuticle almost anywhere on her body. On the contrary, the male of *Eobrachiella* is always found near the base of the female caudal ramus and wrapping arround it with the elongated maxillipeds (see Fig. 10F). This "embracing" type of attachment is much more effective than "pinching" and bears higher selective value for survival as a companion of the parasite living on the fast swimming pelagic fish host.

Eobrachiella elegans f. *seriolae* (Yamaguti and Yamasu, 1960)

(Figs. 10–12)

Material examined: One ovigerous female carrying a dwarf male found at the base of pectoral

fin of a *Seriola quinqueradiata* Temminck and Schlegel caught on 13 May, 1980.

Female: Body (Fig. 10A) rather long. Cephalothorax (Figs. 10B, C) about 1/3 of body length and in line with body axis. Head (Fig. 10D) covered with a dorsal shield. Trunk (Fig. 10A) bearing three pairs of lateral indentations and two pairs of posterior processes, of which the ventral pair is distinctly longer (see Figs. 10E, F). Genital process (Fig. 10E) small. Measurements of specimen (in mm): cephalothorax length 2.75; width 1.4; trunk length 4.83; width 2.58; genital process length 0.49; dorsal process length 1.8; ventral process length 5.2; egg sac length 8.8; width 0.79.

First antenna 4-segmented; first segment unarmed, second and third segments each armed with one seta, and terminal segment (Fig. 11A) with 5 tubercles, 1 digitiform seta and 3 flagelliform setae. Second antenna (Fig. 11B) with a large, fleshy endopod and a small, 2-segmented endopod (Fig. 11C), which is tipped with 2 spiniform setae; no ornamentation on either ramus. Tip of labrum (Fig. 11D) with a short central rostrum concealed in a tuft of setules. Dental formula of mandible (Fig. 11E) typical of *Neobrachiella* with P1, S1, P1, S1, P1, S1, and B5. First maxilla (Fig. 11F) with stubby exopod tipped with 2 setae and large endopod armed with 2 large papillae and 1 short seta; dorsal surface of endopod protruded and spinulose. Second maxillae (see Fig. 10C) rather long, separated, and bearing a pair of nodules at the fused tip (see Fig. 11G). Maxilliped (Fig. 11H) 2-segmented; corpus unarmed; subchela bearing a small basal seta and a stubby distal barb accompanied by a patch of denticles at its base (Fig .11I); terminal claw bearing 2 secondary teeth.

Male: Body (Figs. 12A, B) measuring 1020×460 μm, with a pair of prominent caudal rami. First antenna (Fig. 12C) shaped differently from female but armed with similar kind and number of setae and tubercles (see also Fig. 12D). Second antenna (Fig. 12E) biramus; exopod bearing 2 papillae; endopod 2-segmented, with proximal segment bearing a patch of spinules and distal segment a recurved hook, 2 spines, and a patch of spinules. Mandible with extremely unusual dentition as shown in Fig. 12F. First maxilla (Fig. 12G) generally as in female. Second maxilla (Fig. 12H) 2-segmented and subchelate, with rather strongly curved, slender terminal claw. Maxilliped (Fig. 12I) long and slender; corpus bearing on its medial surface 3 denticulated nodules with the middle one carrying a spine; subchela curbed, bearing a small basal seta, a subterminal denticulate nodule carrying a spine, and a stubby terminal claw (see Fig. 12J).

Remarks. This species of lernaeopodid was reported by Yamaguti and Yamasu in 1960 as "*Brachiella seriolae* n. sp." It has never been reported again since the original work. Our specimen was recovered from the same species of host in the vicinity of the type locality.

A careful comparison between the specimens of Kojima Bay and those of Woods Hole revealed that the differences between them are minute but consistent. Therefore, we propose to treat the Japanese form as a subspecies of *Eobrachiella elegans*.

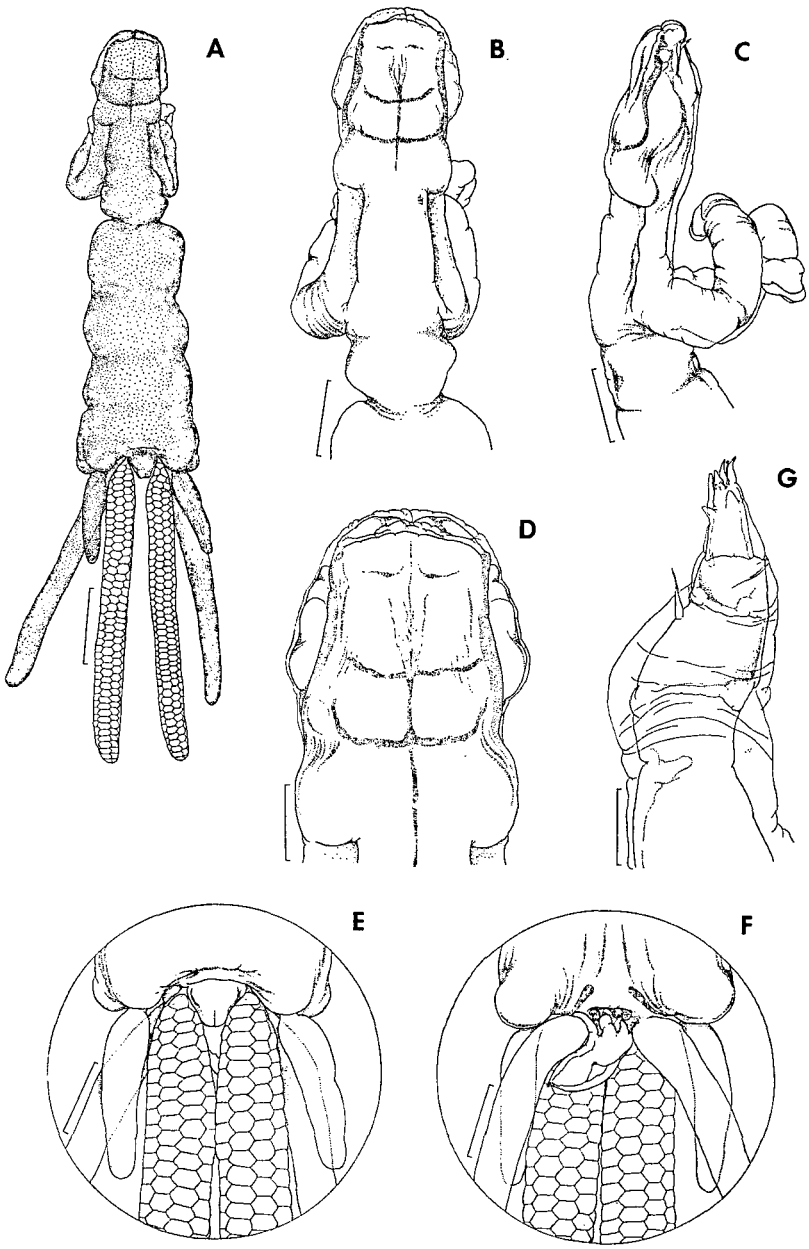

Fig. 10. *Eobrachiella elegans* f. *seriolae* (Yamaguti & Yamasu, 1960), female. A, habitus, dorsal. B, cephalothorax, dorsal; C, same, lateral; D, anterior part of cephalothorax, dorsal, E, posterior end of trunk, dorsal; F, same, ventral. Scale: 2 mm in A; 1 mm in B, C, E, F; 0.5 mm in D.

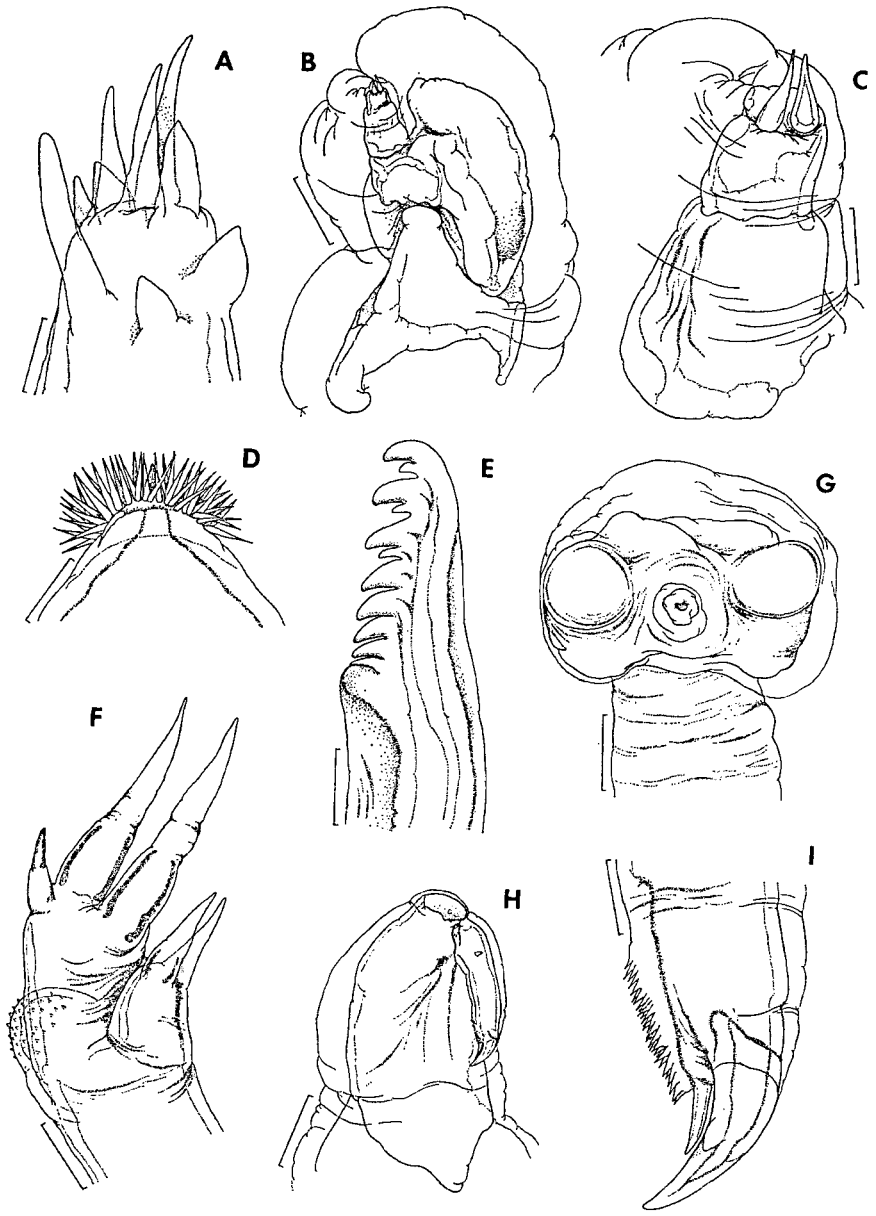

Fig. 11. *Eobrachiella elegans* f. *seriolae* (Yamaguti & Yamasu, 1960), female. A, tip of first antenna; B, second antenna; C, second antenna endopod; D, tip of labrum; E, tip of mandible; F, first maxilla; G, tip of second maxilla; H, maxilliped; I, tip of maxilliped. Scale: 10 μm in A; 0.1 mm in B, H; 20 μm in C, D, E, F, I; 0.2 mm in G.

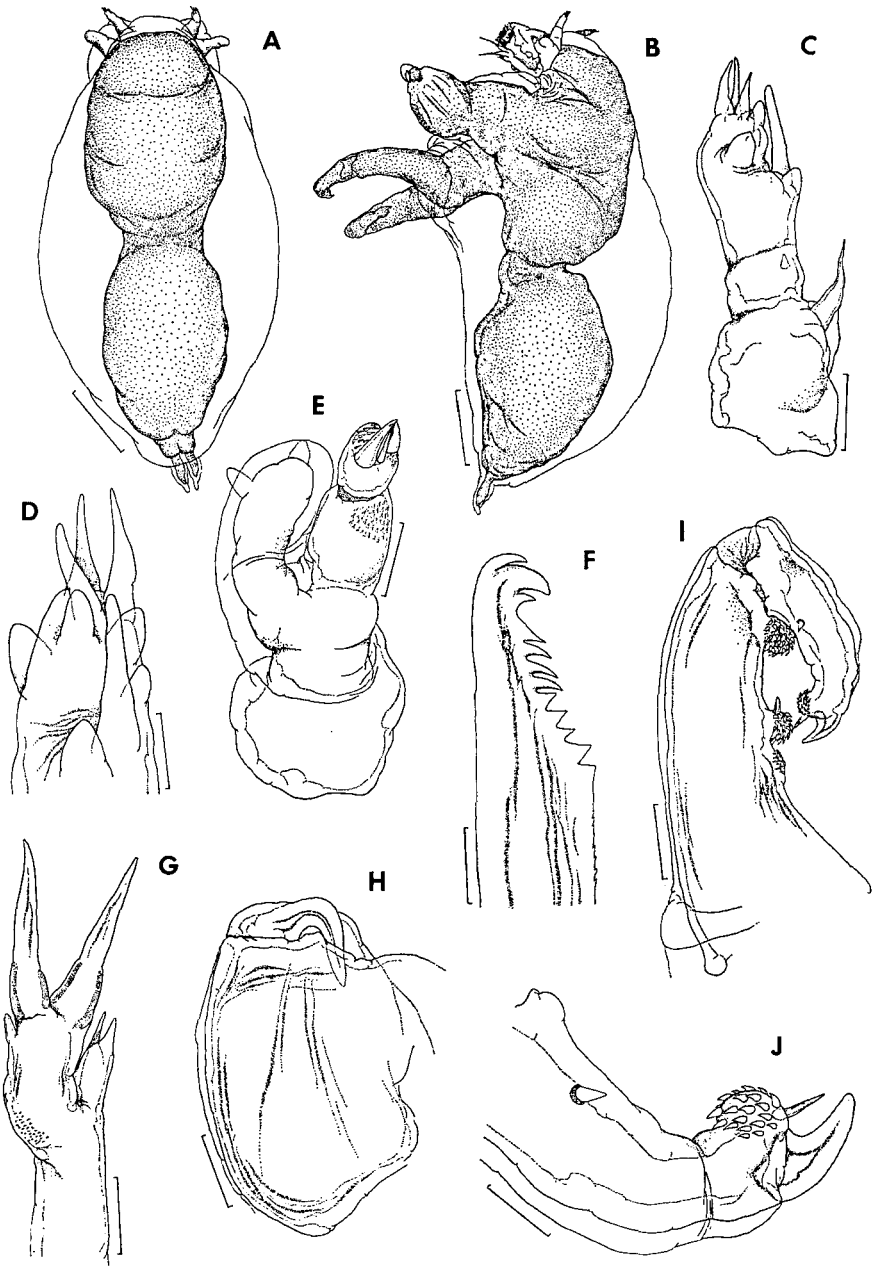

Fig. 12. *Eobrachiella elegans* f. *seriolae* (Yamaguti & Yamasu, 1960), male. A, habitus, dorsal; B, same, lateral; C, first antenna; D, tip of first antenna; E, second antenna; F, tip of mandible; G, first maxilla; H, second maxilla; I, maxilliped; J, tip of maxilliped. Scale: 0.2 mm in A, B; 20 μm in C, E, G, J; 10 μm in D; 7 μm in F; 50 μm in H, I.

The differences detected are in the fine structures of both male and female second antennae and the terminal armature in the male first antennae.

Discussion of *Charopinopsis* Yamaguti, 1963

Prior to 1964, the genus *Charopinus* Krφyer, 1863 was a "catch-all taxon" containing 14 species of morphologically very heterogeneous lernaeopodids. Kabata (1964) reviewed the genus and reassign these 14 species to five genera, with the genus *Charopinopsis* Yamaguti receiving two species of this mixed assemblage; they were: *Charopinus quaterinus* Wilson, 1935 and *Charopinus albidus* Rangnekar, 1956. Since these two species are only remotely related to the redefined genus *Charopinus*, their new attribute—the genus *Charopinopsis*—was not treated by Kabata (1979) as a member on the *Charopinus*-branch of the lernaeopodid phylogeny. Instead, he considered it as representing a stage intermediate between the *Lernaeopoda*-branch and *Brachiella*-branch. Unfortunately, the generic name given by Yamaguti (1963) preceded Kabata's (1964) work, and so we can not but continue the use of this misnomer in accordance with the International Code of Zoological Nomenclature.

According to Kabata's (1979) recent work, *Charopinopsis* is a monotypic genus containing only *Charopinopsis quaterina* (Wilson); as to the other species, *Charopinopsis albida* (Rangnekar), it was reassigned to a newly created genus *Neobrachiella*. The latter taxon, as it stands now, is probably the largest genus of the Lernaeopodidae that contains more than 50 nominal species. However, many of them have never been adequately characterized.

The female of *Charopinopsis quaterina* was excellently redescribed by Kabata (1964), based on Wilson's type specimens. Although Wilson's (1935) original description lacks details, nonetheless, he clearly indicated in his Figure 48 and Figure 49 that the male had a pair of long and slender *Brachiella*-type of maxillipeds. According to our present state of knowledge, it can be briefly characterized that *C. quaterina* is a lernaeopodid with *Brachiella*-type of male and *Neobrachiella*-type of female which possesses: 1) a cylindrical but only moderately elongated cephalothorax, 2) a long trunk with the posterolateral corners protruded into prominent ventral processes, 3) a pair of posterior processes (modified caudal rami) ventral to the egg sacs, 4) a pair of mandibles with two secondary teeth, and 5) a pair of first maxillae with two terminal papillae and a small seta, and a ventral exopod tipped with two small setae. *Eobrachiella elegans* seems to fit well into these character states except for the mandible that bears three secondary teeth.

Since Wilson (1935) had only one male in his collection and did for it a cursory treatment, some unusual features presented in this male had escaped Kabata's (1964) attention when he reconsidered the taxonomic status of "*Charopinus quaterinus* Wilson, 1935." However, blessing in disguise, when one of us (JSH) was making a general collection of parasitic copepods on board R/V *Oregon* during the Cruise 105, he collected 21 females of *C. quaterina* from the gill filaments of two dolphins, *Coryphaena hippurus* Linnaeus, that were caught on November 27, 1965 at 24° 18'N 82° 47'W

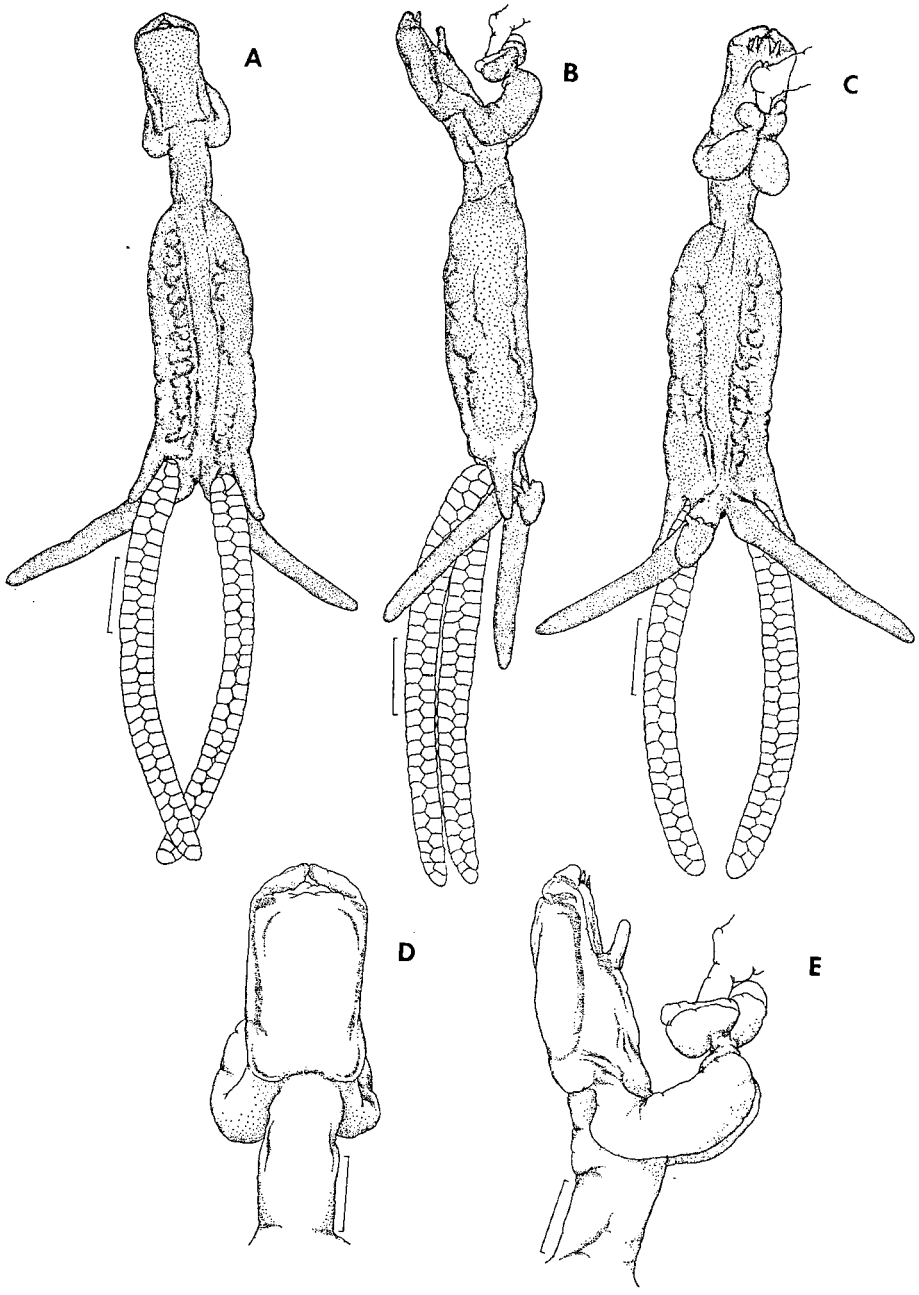

Fig. 13. *Charopinopsis quaterina* (Wilson, 1935) on *Coryphaena hippurus* from Key West, Florida; female. A, habitus, dorsal; B, same, lateral; C, same, ventral; D, cephalothorax, dorsal; E, same, lateral. Scale: 1 mm in A, B, C; 0.5 mm in D, E.

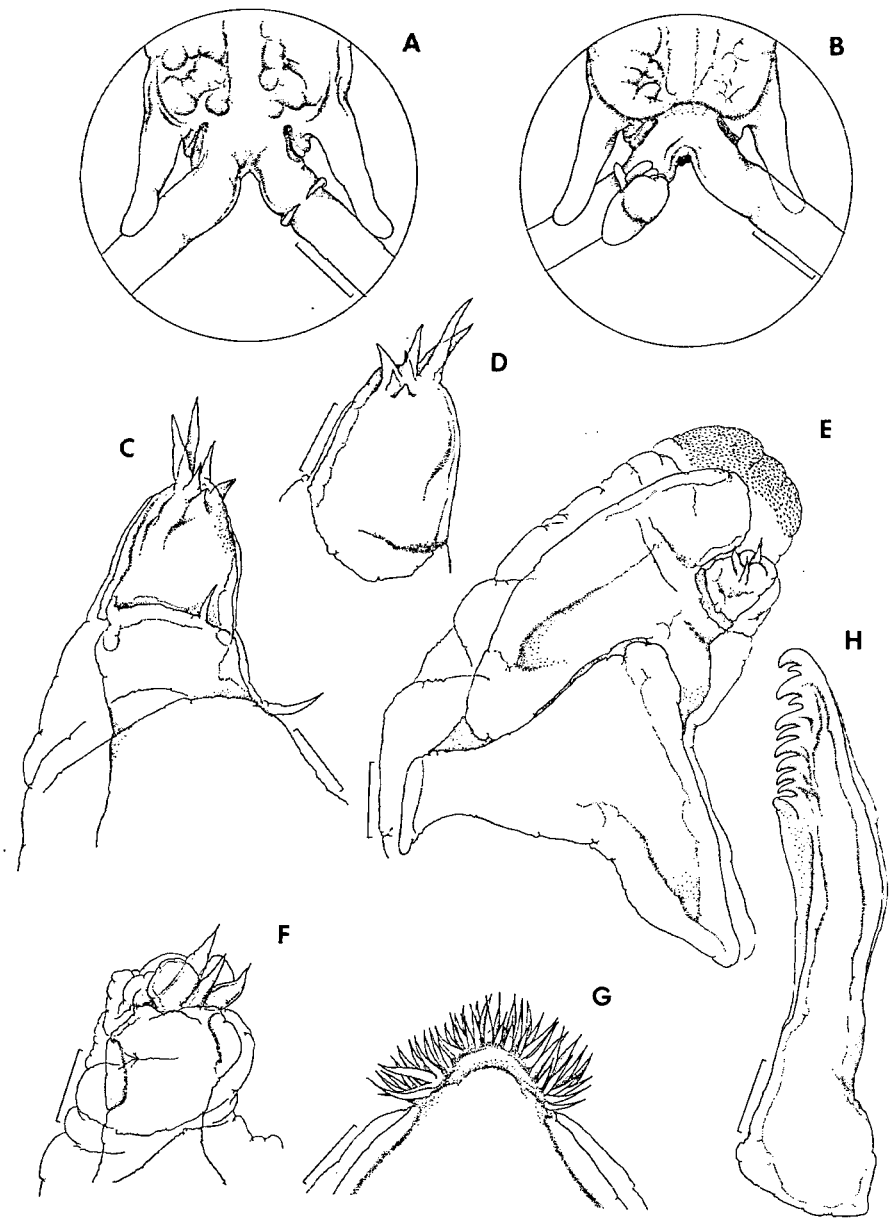

Fig. 14. *Charopinopsis quaterina* (Wilson, 1935) on *Coryphaena hippurus* from Key West, Florida; female. A, posterior end of trunk, dorsal; B, same, ventral; C, first antenna; D, tip of first antenna; E, second antenna; F, second antenna endopod; G, tip of labrum; H, mandible. Scale: 0.5 mm in A, B; 20 μm in C, D, F, G, H; 50 μm in E.

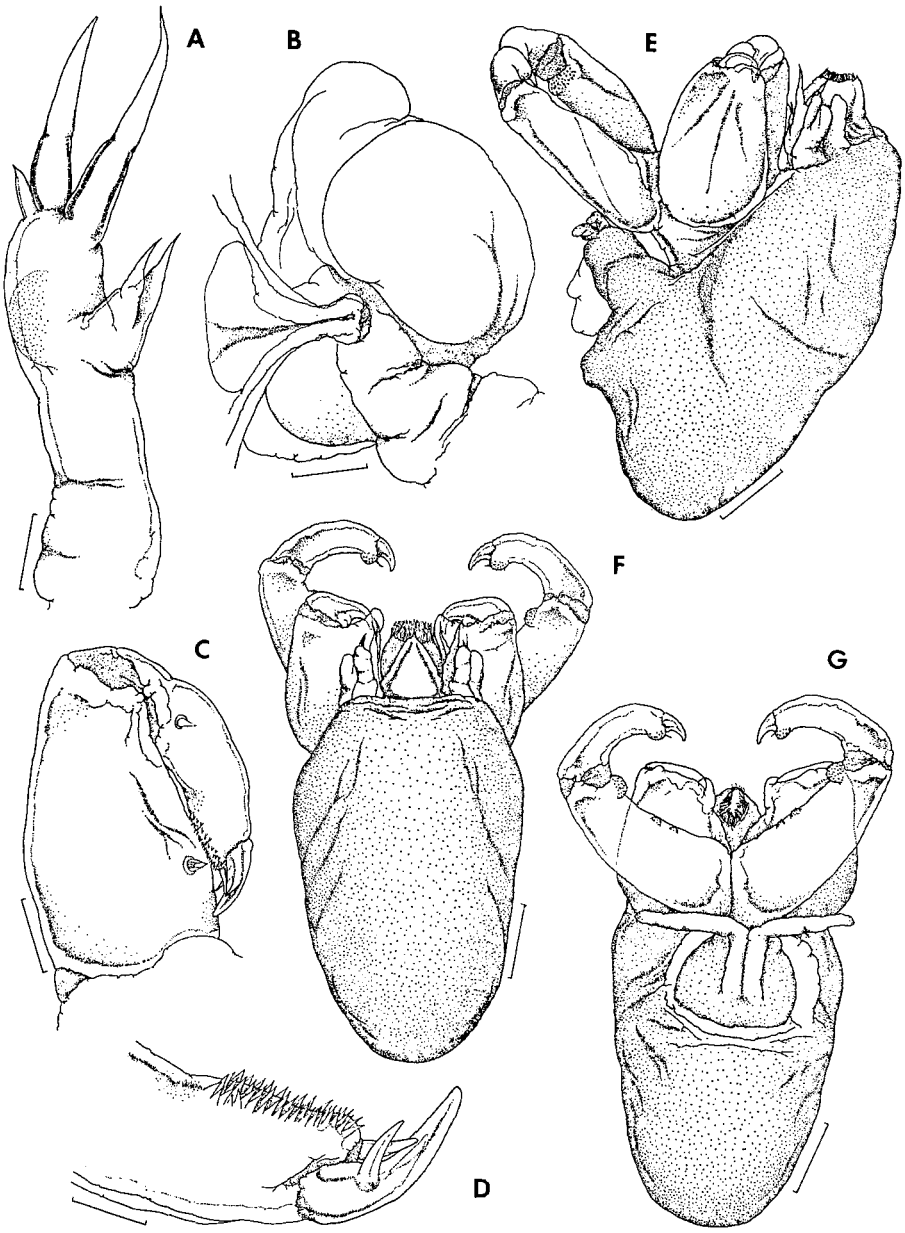

Fig. 15. *Charopinopsis quaterina* (Wilson, 1935) on *Coryphaena hippurus* from Key West, Florida. Female: A, first maxilla; B, tip of second maxillae with bulla; C, maxilliped; D, tip of maxilliped. Male: E, habitus, lateral; F, same, dorsal; G, same, ventral. Scale: 20 μm in A, D; 0.1 mm in B, E, F, G; 50 μm in C.

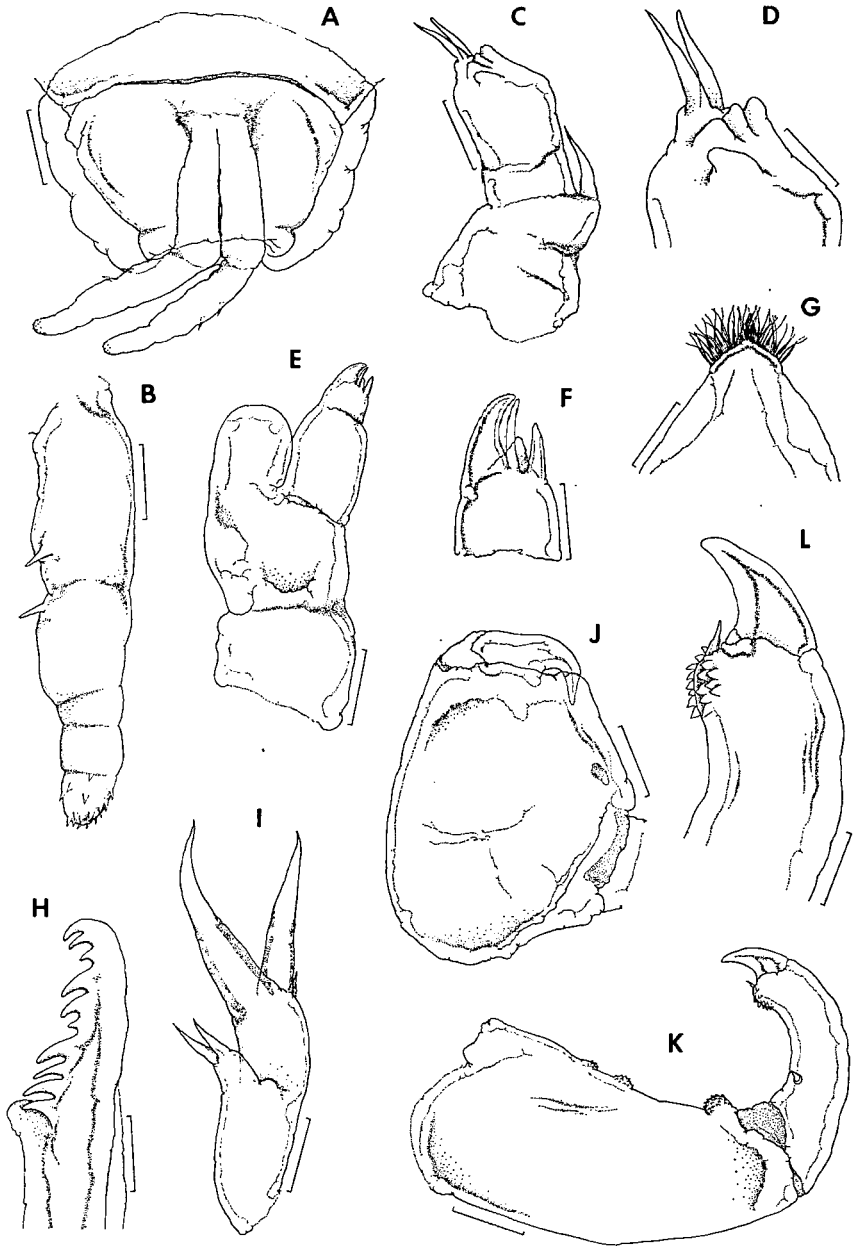

Fig. 16. *Charopinopsis quaterina* (Wilson, 1935) on *Coryphaena hippurus* from Key West, Florida; male. A, posterior end of trunk, showing caudal rami; B, caudal ramus; C, first antenna; D, tip of first antenna; E, second antenna; F, tip of second antenna endopod; G, tip of labrum; H, tip of mandible; I, first maxilla; J, second maxilla; K, maxilliped; L, tip of maxilliped. Scale: 50 μm in A, J, K; 20 μm in B, C, E, G, I. L; 10 μm in D; 7 μm in F, H.

(off Key West, Florida). Ten males were found with each attaching to a female by clasping with its maxillipeds around one of the two modified caudal rami, reminiscent of a situation seen in *Eobrachiella elegans* (cf. Figs. 10F and 14B). In order to find out the true morphological differences between *Charopinopsis* and *Eobrachiella* we decided to study in detail the specimens collected off Key West.

As depicted in Figs. 13–15, the female *Charopinopsis quaterina* has a general appearance of *Eobrachiella elegans*, but differs from it chiefly in the absence of an anal tubercle (cf. Figs. 7C and 14A) and the number of secondary teeth in the mandible (cf. Figs. 8A and 14H). However, the male *C. quaterina* (Figs. 15E–G, 16A–L) has an entirely different type of body, it is not a *Brachiella*-type (type A in Kabata, 1979: 333), but a *Clavella*-type (type B in Kabata, 1979: 333). While the appendages of male *C. quaterina* (Figs. 16A–L) is generally like those in *E. elegans*, its caudal ramus (Figs. 15G, 16A, B) is rather unique in the lernaeopodids. Thus, *Charopinopsis* is an unusual lernaeopodid in possessing a *Brachiella*-type of female and *Clavella*-type of male.

Based on our present knowledge, *Charopinopsis quaterina* is a gill parasite of epipelagic fish, particularly the dolphin, *Coryphaena hippurus* Linnaeus. It is found not only on the dolphins occurring in the Gulf of Mexico and the Straits of Florida (Wilson, 1935; Pearse, 1952; Causey, 1953; Burnett-Herkes, 1974) but also on those populations living in the central Pacific (Lewis, 1967) and the tropical Indian Ocean (Pillai, 1962; Kazachenko, 1975). The parasite is notably lacking on the dolphins from the eastern Pacific, eastern Atlantic, and Mediterranean; and it is still unknow from the dolphin in the Japanese waters. Wilson's (1935) report of finding this parasite "on the gills of a slender gurnard, *Peristedion gracilis*" from the Dry Tortugas (in the Gulf of Mexico) is a rather doubtful record, because the host is not an epipelagic fish.

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